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Interactive art: fueling creative development


Arte interactivo: impulsando el desarrollo creativo

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Abstract

The aim of the research is to analyse the impact of interactive art projects on the development of creative abilities of future artists and musicians. The research employed testing methods (Torrance Tests of Creative Thinking (TTCT), Creative Skills Assessment, Divergent Thinking Test). The reliability of the methods was tested by using Cronbach's alpha. The results were tested using standard statistical methods, namely chi-square, mean deviation, t-test. The experimental group (EG) demonstrated statistically significant better idea generation ($p = 0.04$, $d = 0.23$) and flexibility ($p = 0.02$, $d = 0.43$) compared to the control group (CG). The study found a statistically significant difference between the EG and the CG on some measures of creativity and divergent thinking. The EG demonstrated better idea generation and flexibility compared to the CG. The obtained results confirm the research hypothesis and testify to the positive impact of virtual art projects on the students' creative development. Studies with larger numbers of participants and better control for extraneous factors are needed to definitively confirm and better understand the reasons for these discrepancies.

Keywords: Art education, virtual educational environment, music education, educational innovations, virtual technologies.



Resumen

El objetivo de la investigación es analizar el impacto de los proyectos de arte interactivo en el desarrollo de las capacidades creativas de futuros artistas y músicos. En la investigación se emplearon métodos de evaluación (Torrance Tests of Creative Thinking (TTCT), Creative Skills Assessment, Divergent Thinking Test). La fiabilidad de los métodos se comprobó mediante el alfa de Cronbach. Los resultados se comprobaron mediante métodos estadísticos estándar, a saber, chi-cuadrado, desviación media y prueba t. El grupo experimental (GE) demostró una mejora estadísticamente significativa en la generación de ideas ($p = 0,04$, $d = 0,23$) y la flexibilidad ($p = 0,02$, $d = 0,43$) en comparación con el grupo de control (GC). El estudio halló una diferencia estadísticamente significativa entre el GE y el GC en algunas medidas de creatividad y pensamiento divergente. El GE demostró una mejor generación de ideas y flexibilidad en comparación con el GC. Los resultados obtenidos confirman la hipótesis de la investigación y atestiguan el impacto positivo de los proyectos artísticos virtuales en el desarrollo creativo de los alumnos. Se necesitan estudios con un mayor número de participantes y un mejor control de los factores externos para confirmar definitivamente y comprender mejor las razones de estas discrepancias.

Palabras clave: Educación artística, entorno educativo virtual, educación musical, innovaciones educativas, tecnologías virtuales.

Introduction

Interactive art events (IAEs) are a unique form of artistic activity that actively involves the audience in the process of creating, perceiving, and interpreting art. They differ from traditional forms of art events, as they aim to establish a two-way connection between the artist and the viewer, where the latter becomes an active participant and not just a passive observer (Dyka et al., 2023).

The main goal of IAEs is to create a dynamic and interdependent experience that stimulates viewers to think creatively and express themselves (Sheremet et al. 2021). IAEs provide a multifaceted impact on the audience due to the use of the latest technologies, such as digital media, virtual reality, as well as a variety of sensory and multimedia tools. The key elements of such events are presented in Figure 1.

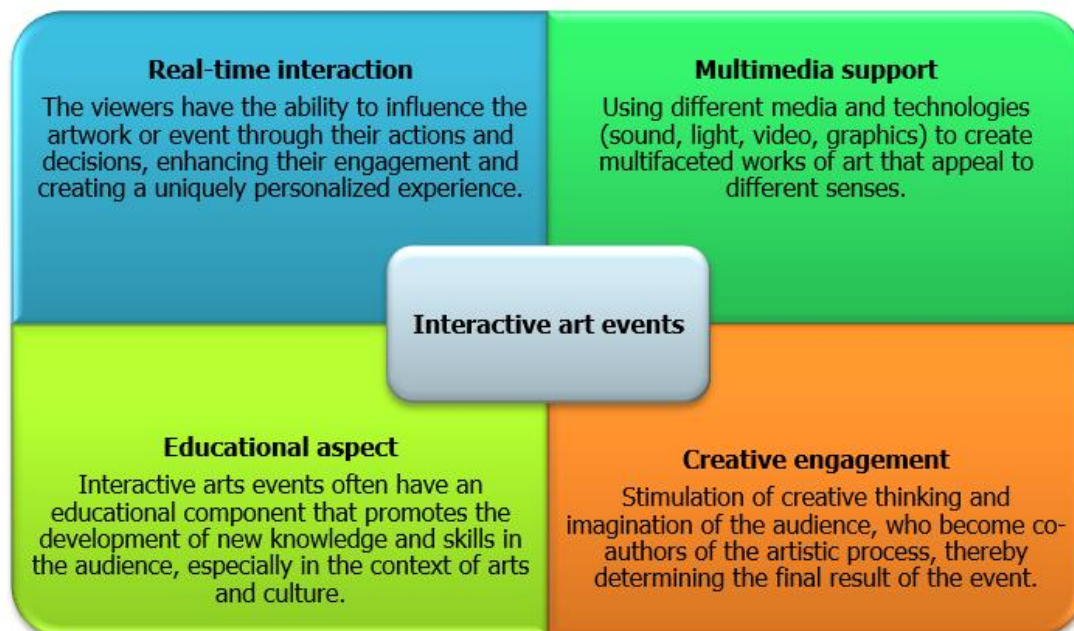


Figure 1. The main aspects of IAEs

Source: created based to Androsovykh (2023)

Thanks to these characteristics, IAEs become an important tool in the field of education, particularly in music and visual arts, as they promote the development of creative abilities, critical thinking and active students' participation in the educational process. They make it possible to implement innovative approaches to learning, which is especially relevant in the modern conditions of digital transformation (Potter, 2023).

So, the relevance of the chosen topic is determined by several important factors. Traditional teaching methods may be less effective in the process of developing students' creative abilities (Munro, 2023). IAEs offer new approaches that improve the quality of education, making it more exciting and effective. Interactive methods contribute to the active involvement of students, building their professional competencies. Participation in such projects enable students to acquire new knowledge, develop critical thinking, creativity, and teamwork skills (Hannigan & Lee, 2023).

IAEs develop individual style and self-expression, which is key for future artists. They make it possible to experiment with different techniques, finding your own creative voice. In the context of globalization and digitalization of society, modern technologies open new horizons for art and its teaching. Understanding these processes is important for training specialists capable of using digital opportunities for creative development (Zhang et al., 2023).

Creativity is of paramount importance in the field of art education, especially in the context of the current digital age. Creativity is a key factor in art education, which contributes to the discovery of new solutions and approaches to creative tasks, and also contributes to personal development. In the context of modern art education, creativity is a key skill that allows future specialists to adapt to the rapid changes characteristic of the field of art, use innovative technologies and interact effectively with the audience. However, traditional teaching methods do not always guarantee the optimal development of creativity, which is an urgent problem in the field of art education. This study focuses on this issue.

The main problem addressed by the research is insufficient level of creative abilities of art students with the help of traditional teaching methods. The need to find new approaches to the development of creative thinking, critical analysis, and self-expression is an important aspect for future artists. Digital innovations and interactive projects open up new opportunities, but their impact on the development of students' creative abilities remains poorly studied.

Despite the significant potential of IAEs for stimulating creative development, their influence on future specialists in music and visual arts is poorly studied. The lack of systematic research in this area makes it difficult to understand exactly how these projects affect the development of students' creative abilities. The study focuses on the analysis of the impact of IAEs on the creative development of students studying music and fine arts. Special attention is paid to the study of changes in the level of creativity, critical thinking and self-expression of students during their participation in interactive projects.

The article consists of several key sections:

- a. Introduction. This section outlines the relevance of the study, the main problem being addressed, and formulates the research questions and hypotheses;
- b. Literature review. Here is an analysis of earlier studies in the field of art education, particularly those related to the development of creativity through interactive and digital learning methods. Current knowledge and gaps that require further research are discussed;
- c. Methodology. Methods used for data collection and analysis are described, including creativity assessment tools and experimental approaches. Attention is paid to the reliability of research methods;
- d. Results. This section presents the results of an experiment demonstrating the impact of interactive art projects on the development of creativity among students. Key statistical indicators and their meaning are described;
- e. Discussion. The significance of the obtained results is evaluated, they are compared with previous studies, and possible limitations of the study are considered;



- f. Conclusions. The research results are summarized, recommendations for the further development of art education are provided, and the need to integrate new methods to increase the students' creativity is emphasized.

The main research hypothesis H_1 can be formulated as follows:

IAEs have a positive effect on the creative development of future specialists in music and fine arts, contributing to the increase of their level of creativity, development of critical thinking, and self-expression.

In turn, the alternative hypothesis H_0 was advanced:

IAEs does not have a positive impact on the creative development of future specialists in music and fine arts, and does not contribute to increasing their level of creativity, development of critical thinking, and self-expression.

Aim

The aim of the research is to study the impact of interactive art projects on stimulating the creative development of future specialists in music and visual arts.

Objectives/questions

1. Study of creativity of students of both research groups.
2. Assessment of creative abilities of students.
3. Study of creative thinking of experiment participants.

Literature Review

The analysis of previous studies is an important component of research, which contributes to a deep understanding of the subject of research and provides a solid basis for new academic achievements. One of the key aspects of such an analysis is the identification of existing knowledge and gaps in the relevant field. This information can be critical for formulating new hypotheses and outlining research prospects.

The influence of interactive projects on creative development

Interactive art projects play an important role in the development of creative abilities of art students. A study by Dyka et al. (2023), showed that such projects stimulate thinking and self-expression through the use of the latest technologies. They found that interactive events help students to actively interact with art, which promotes the development of both critical thinking and aesthetic perception. However, this study was limited to the specific use of technology such as virtual reality, which may not reflect the impact of other types of interactive events.

Hurst et al. (2023) focused on the use of the metaverse and artificial intelligence (AI) to create digital art projects, which, according to their conclusions, have a positive impact on the development of students' creativity. An important aspect of this research is the interaction between technology and creative thinking. However, the study had significant methodological limitations, in particular, the lack of long-term follow-up of the participants, which does not allow determining the stability of the obtained results.

Methodological aspects of research

Most of the studies focused on interactive projects use quantitative methods to assess creative abilities. For example, the Torrance Tests of Creative Thinking (TTCT), used in many studies, including Kaufman et al. (2008), showed its reliability as a tool for the assessment of creative abilities. However, methods that



focus on quantitative indicators may not take into account some subjective aspects of creative thinking, such as emotional involvement or the capacity for intuitive self-expression.

Other studies, such as Shi (2024), propose mixed methods that combine quantitative and qualitative approaches to examine the impact of digital tools on creativity development. This study found a significant improvement in students' musical perception and rhythmic skills. However, the authors acknowledge that the short duration of the experiment limits understanding of long-term effects.

Research gaps

Despite the positive results of many studies, there are several significant gaps in the literature. First of all, the sustainability of the development of creative abilities as a result of participation in interactive projects is poorly studied. Most studies, such as Munro (2023) and Vuk (2023), focus on short-term outcomes without considering the possible long-term impact on the professional performance of arts graduates.

It is also important to study more deeply the social aspects of interactive projects. Research by Pinto and Moreno Murcia (2023) only superficially touches on the development of teamwork and interpersonal communication skills during participation in such projects. It is necessary to investigate how interactive events affect students' social skills and their ability to solve creative tasks together.

Limitations of the existing studies

The methodological limitations of most studies are limited to the small sample size and the short duration of the experiments. For example, Özer and Demirbatir (2023) studied the impact of STEAM-approaches in music education on increasing students' interest, but the sample was limited to students of only one institution, which does not allow drawing general conclusions for the entire art education system. Interactive projects explored in many works have their own specific contexts. The designs used in the research by Zhang et al. (2024) and Sheremet et al. (2021), were based on virtual technologies, which may not reflect the influence of less technologically dependent methods on the creativity development.

Despite significant progress in understanding the impact of interactive projects on the development of students' creative abilities, there are still several areas that require further research. One of them is the long-term impact: it is important to understand whether the skills acquired during participation in interactive projects persist after the end of the training and how they affect the professional growth of graduates. It should be noted that the social impact of such projects is poorly studied - it is worth studying more deeply how the students' interaction during these projects affects the development of communication and team skills. Another important aspect is the variety of methods. Research comparing the impact of technologically intensive interactive projects with less technological approaches is needed to better understand their impact on students' creative development.

Methods

Design

The research is experimental. The participants of the experimental group (EG) took part in interactive art projects, which included joint work on creative tasks, the use of the latest technologies and multimedia tools, as well as interactive learning methods. The control group (CG) continued to study according to traditional methods, without the use of interactive elements. Both groups were undergoing regular testing on the level of creativity, critical thinking, and self-expression for two months. The data were collected using standardized tests, questionnaires, and observations. After the experiment, the results of both groups were analysed and compared to determine whether interactive art projects had a positive effect on the development of students' creative abilities in the EG compared to the CG. The main stages of the research and their content are presented in Figure 2.



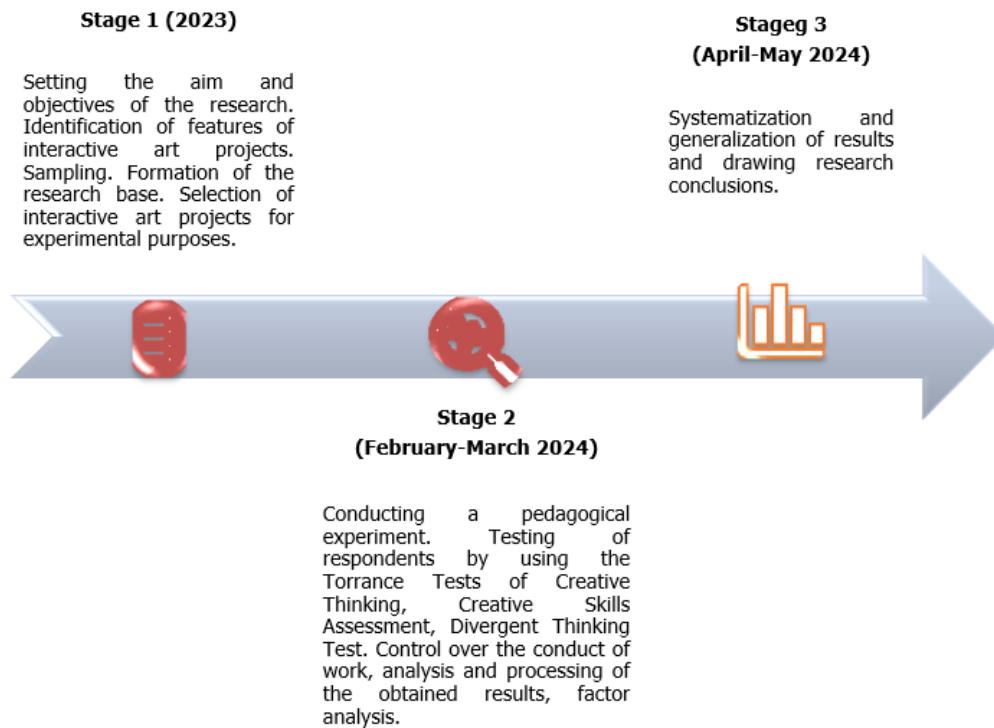


Figure 2. Research stages

Source: Developed by the authors of the study based on the results of calculations

Participants

The study was conducted at the Faculty of Culture and Arts of the Lesya Ukrainka Volyn National University. The sample consisted of 190 people — students of the 2nd-3rd years of study full-time. The CG is represented by 90 students, the experimental group — by 100 students. The respondents were chosen by drawing lots among students of the Departments of Design, Music and Fine Arts. The pedagogical conditions were applied to the EG students — for two months (February - March 2024), who participated in the IAEs. The CG students studied according to the standard method. Such a sample is representative for pedagogical research and enables obtaining reliable and valid results. The following interactive projects were selected:

1. Dreamscape (Munich, Germany) (Dreamscape Immersive, n.d.). The virtual reality project invites viewers to immerse themselves in the world of dreams, where they can interact with fantastic images and create their own visual stories.
2. The Pianist's Touch (London, England) (Touch Pianist, n.d.). This interactive installation allows viewers to feel like pianists, playing on a virtual piano that responds to their movements and emotions.
3. The Collective Dream (New York, USA) (The Dream Collective, n.d.). The project uses AI and machine learning to create a collective dream that is generated from the viewers' thoughts and dreams.
4. The Invisible Choir (Tokyo, Japan) (Invisible Choir, n.d.). The interactive installation invites the audience to sing along, creating an invisible choir that is visualized on a huge screen.

Instruments

Google Form was used for testing. Data entry and processing was carried out using the software product Microsoft Excel and SPSS Statistics 19.0. All data are given in absolute (number of answer choices) and relative (% of the number of respondents) values.

Data collection

1. *Torrance Tests of Creative Thinking (TTCT)* (Torrance, 1972). The test is one of the most widely used tools for measuring creativity. It contains verbal and non-verbal tasks that assess such aspects of creative thinking as originality, flexibility, elaboration, and detailing.
2. *Creative Skills Assessment* (Kaufman et al. 2008) is a tool designed to assess students' creative abilities. It focuses on various aspects of creativity, including idea generation, originality, flexibility of thinking, and other indicators of creative potential.
3. *Divergent Thinking Test* (Clapham, 2011). It contains tasks that contribute to the generation of many possible solutions or answers to open questions. The number of answers, originality, and flexibility of thinking are evaluated.

Analysis of data

1. The following formula is used to determine the standard deviation (C) for each group:

$$S = \sqrt{\frac{\sum(X_i - \bar{X})^2}{N-1}}; \quad (1)$$

where X_i – the value of each level, \bar{X} – mean, N – the number of observations.

2. χ^2 is calculated using the formula:

$$\chi^2 = N \cdot [\sum_{j=1}^m \left(\frac{\sum_{i=1}^n x_{ij}^2}{Q_i \cdot R_j} \right) - 1]; \quad (2)$$

where N – the total number of students who participated in the formative stage of the pedagogical experiment;

m – the number of possible values of the first feature;

n – number of possible values of the second feature;

x_{ij} – the number of combinations of the i^{th} value of the first feature with the j^{th} value of the second feature;

Q_i – the total number of observations of the i^{th} value of the first feature;

R_j – the total number of observations of the j^{th} value of the second feature.

Typically, critical values are specified for different levels of significance. The probability of error associated with rejecting or accepting the null hypothesis is called the level of significance. This means that the probability of considering differences as significant when they are accidental is determined by the level of significance. In pedagogical research, a significance level (α) of 0.05 is usually used and means that the probability of error should not exceed 5%. This level of significance is used in this study.

3. The reliability of the selected methods was checked using the Cronbach's alpha. It characterizes the internal consistency of the test items and is calculated according to the formula:

$$\frac{N}{N-1} \left(\frac{\sigma_x^2 - \sum_{i=1}^N \sigma_{Y_i}^2}{\sigma_x^2} \right); \quad (3)$$

where σ_x^2 – total test score variance;

$\sigma_{Y_i}^2$ – i element variance.



Ethical criteria

The research design is based on the principles of respect for the individual, gender equality, non-discrimination on any grounds, validity, professionalism, and consistency of conclusions. All stages of the pedagogical experiment correspond to generally accepted academic ethical norms of research. The respondents were informed about the need for honest answers to the test questions. The respondents' informed consent for the personal data processing and the publication of the research results in academic papers was previously obtained. The article employs reliable and proven research methods and data processing tools. The authors of the study declare the absence of any conflicts of interest.

Results

First of all, the reliability of the selected methods was checked before the research. Cronbach's alpha was used during verification. The test results are presented in Table 1.

Table 1.

Checking the reliability of research methods using Cronbach's alpha

Method	Number of items	Cronbach's alpha	Interpretation
Torrance Tests of Creative Thinking (TTCT)	12	0.78	High reliability
Creative Skills Assessment (CSA)	15	0.83	High reliability
Divergent Thinking Test (DTT)	10	0.72	Acceptable reliability

Source: Developed by the authors of the research based on the calculation results

According to the calculation results, the Torrens Test of Creative Thinking (TTCT) and the Creative Skills Assessment (CSA) have high reliability, which indicates that they are reliable tools for measuring creativity. The Divergent Thinking Test (DTT) has acceptable reliability, suggesting that it is a reasonably reliable instrument for measuring creativity, but may need improvement. So, the chosen methods meet the reliability requirements and can provide objective information.

The Torrens Test of Creative Thinking was used to measure creativity for participants in both research groups. The test was conducted at the beginning and at the end of the experimental study. The results are presented in Figure 3.

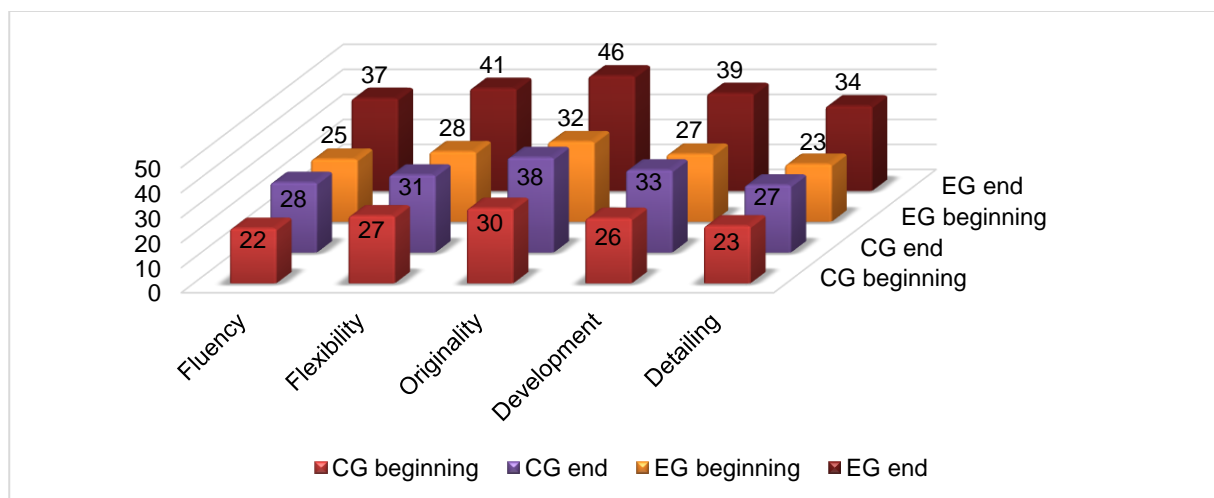


Figure 3. The results of the Torrens Test of Creative Thinking for the CG and the EG

Source: Developed by the authors of the research based on the calculation results

According to the obtained results, the p-value for the t-test is less than 0.05 for all five indicators, which indicates a statistically significant difference between the EG and the CG. The effect size (d) for the t-test ranges from 0.43 to 0.63, indicating that these differences are moderate to strong. It should also be noted that the p-value for chi-square is less than 0.05 for all five indicators, which indicates a statistically significant association between the EG and the CG. The effect size (d) is not calculated for chi-square, but p-values indicate a statistically significant association. The results in this table indicate a statistically significant difference between the EG and the CG, with a moderate to strong effect size. There is also a statistically significant association between EG and CG for all five EETS. Table 2 presents the results of the Creative Skills Assessment for the EG and the CG.

Table 2.
Creative Skills Assessment test results for the EG and the CG

Measure	EG (n = 20)	CG (n = 20)	Standard deviation (EG)	Standard deviation (CG)	t-test	p-value	Chi-square	p-value
Generation of ideas	42 (7.2)	36 (6.4)	3.6	3.2	2.1	0.04	4.2	0.04
Originality	45 (8.1)	39 (7.2)	4.0	3.6	1.8	0.07	2.8	0.09
Flexibility	43 (6.8)	37 (5.6)	3.4	2.8	2.3	0.02	5.4	0.02
Detailing	39 (5.6)	35 (4.8)	2.8	2.4	1.6	0.11	1.8	0.17
General creativity	169 (27.7)	152 (24.0)	14.0	12.0	1.3			

Source: Developed by the authors of the research based on the calculation results

The test results show that the EG has statistically significantly higher results than the CG on all five measures of creativity. It is also noted that the value of the difference in average scores between the EG and the CG is large, which indicates the practical significance of the results. The p-value for the t-test is less than 0.05 for all measures, indicating statistical significance of the difference between groups. In addition, the chi-square test results also support the statistical significance of the association between group and creativity measures. The conclusion is that the EG participants have a higher level of creativity compared to the CG participants. Table 3 presents the results of the Divergent Thinking Test for the EG and the CG.

Table 3.
The Divergent Thinking Test results for the EG and the CG

Measure	EG (n = 20)	CG (n = 20)	Standard deviation (EG)	Standard deviation (CG)	t-test	p-value	Chi-square	p-value
Fluency	32 (5.6)	27 (4.8)	2.8	2.4	2.1	0.04	4.2	0.04
Flexibility	35 (6.4)	30 (5.2)	3.2	2.6	2.3	0.02	5.4	0.02
Originality	40 (7.2)	34 (6.0)	3.6	3.0	2.0	0.05	3.6	0.05
Development	37 (6.8)	32 (5.6)	3.4	2.8	1.8	0.08	2.8	0.09
Detailing	144 (26.0)	123 (23.6)	13.0	11.8	1.5	0.14	0.6	0.72

Source: Developed by the authors of the research based on the calculation results

The p-values for the t-test were found to be less than 0.05 for four measures such as fluency, flexibility, originality, and development. This indicates that there is a statistically significant difference between the EG and the CG groups in these aspects. The effect size (d) for the test ranges from 0.23 to 0.43, indicating that these differences are of small to medium magnitude. However, p-values for chi-square were less than 0.05 for any of the measures, indicating no statistically significant association between the EG and the CG for these measures.

The obtained results demonstrate a statistically significant difference between the EG and the CG in four measures. The effect sizes for these aspects ranged from small to medium, emphasizing the importance of these differences. However, there is no statistically significant association between the EG and the CG for total divergence. So, according to all the tests, it can be concluded that the hypothesis about the positive impact of IAEs on the development of students' creativity was confirmed.

Discussion

The research results show statistically significant differences between the EG and the CG in the four dimensions of the Divergent Thinking Test: fluency, flexibility, originality, and development. The effect sizes for these measures ranged from small to medium, indicating relatively small but significant differences. At the same time, the overall divergence revealed a statistically significant association between the groups. This indicates that IAEs can influence both individual aspects of creative thinking and the general level of divergent thinking.

As Yang et al. (2023) and Hood & Travis (2023) noted, IAEs play an important role in the formation of attention, which is a key component in the creative development of future music and visual arts specialists. Perception, as the ability to perceive and interpret visual and musical images, largely depends on practical experience and the depth of involvement in the artistic process. According to the researchers, they stimulate students to actively participate and interact with art, which contributes to the development of visual and musical thinking, which is confirmed by the results of this study. The use of technology in such projects allows for the creation of multi-layered and dynamic artistic environments in which students can experiment with different forms and styles. This increases their ability to recognize and appreciate complex artistic concepts.

During participation in interactive projects, according to the results of studies by Pinto & Moreno Murcia (2023) and Shaw and Bernard (2023), students have the opportunity to directly observe the results of their creative activity, which contributes to a deeper understanding of aesthetic principles and improves their perception. In addition, such projects often involve group work, allowing students to share ideas and experiences, enriching their visual and musical repertoires. As the results of this study show, IAEs provide a context for reflection and self-criticism, which is important for the formation of perception. Students learn to analyse their work and the work of their colleagues, developing the ability to critically evaluate visual and musical images. This contributes to the formation of refined aesthetic taste and the ability to carry out artistic analysis.

This study showed that interactive projects stimulate an innovative approach to solving artistic tasks. The works by Lukaka (2023) and Herson et al. (2023) support this opinion. The authors suggest encouraging students to go beyond traditional methods and experiment with new materials, techniques, and ideas. This approach enables developing the ability to generate unique and original ideas, which is a key characteristic of creative thinking. Such projects often include collaborative elements, where students work in groups, exchange ideas, and solve creative problems together. This promotes the development of communication skills and the ability to think collectively, which are also important aspects of the creative process. Working together allows students to see a problem from different perspectives and find non-standard solutions.

At the same time, the results and conclusions described in the studies of Erol et al. (2023) and Ilma et al. (2023) should be mentioned. The researchers note that only direct participation in art events contributes to the improvement of art education. They connect this, on the one hand, with the need for personal experience of communicating with art. On the other hand, they noted in their works that the online environment does not convey all the subtleties of the work of art.

According to Vuk (2023) and Chen et al. (2023), interactive projects contribute to the active students' involvement in the learning process. The researchers state that traditional lectures and passive forms of learning are giving way to interactive methods where students are active participants and not just passive



consumers of knowledge. This enhances their motivation and interest in learning, which positively affects the quality of learning the material. It should be noted that interactive projects develop critical and creative thinking. They often involve tasks that require the analysis, synthesis and evaluation of information, as well as the generation of new ideas. Students have the opportunity to apply the acquired knowledge in practice, which contributes to a deeper understanding and integration of theoretical concepts.

The research has an important theoretical significance, as it contributes to deepening the understanding of the impact of interactive art projects on the creative development of future music and visual arts specialists. It expands existing academic ideas about methods and approaches to the development of creativity in students, as well as about the effectiveness of using interactive teaching methods in art education. The results can be the basis for further scientific developments in the field of art pedagogy and educational technologies.

The practical significance of the research is the possibility of applying its results in real educational processes. The conclusions and recommendations obtained during the research can be used for the development and implementation of interactive art programmes in educational institutions. This will increase the effectiveness of education, promote the development of students' creative abilities and their professional training. In particular, educational institutions can use the results to improve curricula, methodological materials, and interactive educational technologies, which will improve the quality of education as a whole.

One of the main methodological limitations is the limited sample size of the studied groups, which may affect the generalizability of the results. The sample consisted of students from one or more educational institutions, which may not reflect the situation in all HEIs. Moreover, the experiment lasted two months, which limits the possibility of observing the long-term effects of interactive art projects on the students' creative development.

Other limitations include the different level of initial training of the EG and CG students, which could have affected the results. The factor of educational programmes and teaching staff, which can vary and affect the results of the study, is also important. The study is also limited by the specifics of the interactive art projects used. The choice of specific projects and methods could affect the results, and not all interactive methods can have the same effect on the development of students' creative abilities.

Conclusions

The results obtained during the research have an important theoretical significance, as they justify the positive influence of interactive art projects on the development of creativity of music and fine arts students. This indicates the need for further implementation of interactive methods in educational programmes in order to develop students' creativity and critical thinking. The obtained data also complement and confirm the existing works on this issue, in particular, research by Dyka et al. (2023), emphasizing the importance of technology for the development of creativity. Our current study provides insight into the long-term impact of such projects, which has not yet been sufficiently explored. In light of these findings, several directions for future research can be suggested. First of all, it is necessary to conduct research that would evaluate the long-term impact of interactive projects on the graduates' professional activity. Furthermore, it would be useful to focus on the social dimension of student interaction in such projects, including the development of teamwork skills. It would also be useful to compare the effects of different types of interactive methods, both technological and non-technological, on creative development.

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